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The Evolution of Trade and Technology in the Italian Regions

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ABSTRACT

Within the European arena, the heterogeneous socio-economic conditions of the Italian regions are a clear example of intra-border imbalances. In fact, the different growth rates characterising the Italian regions are far to be an exception in the Union, where heterogeneities across member states are a reflection of domestic socio-economic disparities re-produced over time.

Differences in growth differentials, trade and technological sectoral patterns within Europe at national level call for further intra-border investigations. Existing studies have neglected territorial disaggregations more detailed than the national one. Similarly, although relative large streams of (both theoretical and empirical) literature have investigated the relationship between growth differentials and technology, relative little attention has been devoted to the evolution of technology and trade specialisation. On this respect, the novelty of the analysis carried out in this paper lies in the attempt to fill the gap by focusing on the relationship between technology and trade over time from a geographical perspective centred on the *regional space*. In this context, the hypothesis of whether the technological effort impacts on regional internationalisation (understood in terms of international trade) over time is tested. The ultimate aim is to explain current *leading* and *lagging-behind* conditions by identifying regional profiles of industrial structure.

JEL Classification: F10, O3, R10

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Abstract - Within the European arena, the heterogeneous socio-economic conditions of the Italian regions are a clear example of intra-border imbalances. In fact, the different growth rates characterising the Italian regions are far to be an exception in the Union, where heterogeneities across member states are a reflection of domestic socio-economic disparities re-produced over time.

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1. Introduction

The deepening of the integration process with the acceleration of the Single European Market (SEM), the forthcoming adoption of a single currency together with the political plans of eastwards enlargement of the European Union (EU) rise problems of disparities and inequalities *between* and *within* member states. The existence of *cross-border* imbalances within the EU area and the relevance of the issue for a successful socio-economic integration have been widely pointed out by the literature. The convergence in GDP levels across the EU regions registered up to the 1970s slowed

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down in the 1980s and started to reverse in the early 1990s. The awareness of this phenomenon has promoted the flourishing of socio-economic investigations based on the *region* as a territorial unit of analysis in order to better understand local dynamics driving convergence/divergence processes. Amidst the more general globalisation trend, localised knowledge spillovers and geographical concentration of economic activity seem to underlie these processes. In fact, despite of the fast pace of technological change and the massive reduction of space and time constrains, geographical agglomeration matters more than ever before for the purpose of global competitiveness.

If the geographical perspective has shifted from the national to the regional level in the investigation of growth differentials, it has also turned out that innovative capabilities account for a good deal in explaining inter-regional disparities. The latter seem to greatly depend upon local innovative capacities, without, however, disregarding economic-structural and institutional factors. Structural and innovative processes are closely connected and mutually reinforced by *virtuous* and *vicious* circles, characterising respectively "success stories" of rapid industrial and technological development and catching up, and "falling behind" models of insufficient structural change and lack of organisational flexibility and systemic interaction. Within the European arena, the heterogeneous socio-economic conditions of the Italian regions are a clear example of intra-border imbalances. In the Italian peninsula, the north-south gap, reflected in the distinction between most advanced and less favoured regions, calls for a better understanding of both structural and technological profiles of the *regional sectoral systems*.

By providing further insight into the convergence/divergence processes of regional industrial systems in Italy, this paper attempts to identify production and innovative potentials developed within each regional unit. The ultimate aim is to explain current *leading* and *lagging-behind* conditions. For this purpose, economic, technological and locational factors are evaluated. As the heterogeneity of the Italian regional systems is far to be an exception in the EU, the results of this analysis and their policy implications may well be relevant to the domestic realities of other member states.

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Going into the details of the analysis, the paper tests the hypothesis of whether the technological effort impacts on regional internationalisation (understood in terms of international trade) over time. The paper is organised in six main sections. The following section provides the theoretical background. Section 3 discusses the data adopted. In section 4, the evolution of sectoral trade specialisation is sketched in order to evaluate the trajectories of regional competitive patterns. The emphasis on the sectoral aspects will encompass implications for regional technological specialisations and their consequent convergence/divergence over time. Section 5 tests the hypothesis stated above and discusses the results. Moreover, in order to evaluate the significance of cross-regional differences in this context, the investigation goes further by identifying regional profiles of production structure. Section 6 draws some conclusions.

2. Regional space, trade and technology

The deepening of the European integration process has taken place in an era of major structural changes encompassed in the globalisation of economic activity, the transition to a post-fordism system of production and the fast pace of technological change. Such phenomena have emphasised the falling down of space and time barriers as well as the significance of local space for the purpose of global competitiveness. Despite of the seemly contradictory character of this assertion, the current techno-socio-economic conditions have amplified *localised knowledge spillovers* and *geographical concentration of economic activity* as key factors of international performance. Accordingly, the need for a redefinition of the terms under which convergence/divergence processes between territorial entities occur and can be investigated has risen.

This issue gains particular momentum in the EU context, where the completion of the SEM, the adoption of a single currency together with the likelihood of an eastwards enlargement of the Union rise problems of disparities and inequalities *between* and *within* member states. Against the neoclassical prediction that output (income) of different territorial units should tend to converge over time towards a steady-state, the existence of imbalances within the EU area has been widely acknowledged by the literature as a major challenge to successful socio-economic

integration. Empirical findings reveal a failure of trade liberalisation in presence of increasing returns or agglomeration economies to accelerate convergence (Neven and Gouyette, 1995). The "new" trend identified in empirical studies (e.g. Fagerberg and Verspagen, 1996) concerns differences in growth rates wider across regions than across member states.

The regional space

The "local" nature of the factors highlighted above (i.e. knowledge spillovers and spatial concentration of economic activity) together with the empirical evidence of the 1970s slowdown in GDP convergence across EU regions and the 1980s reverse of this process, call for a spatial analysis able to overcome the limits of a geographical perspective centred on the nation-State. The awareness of this phenomenon has promoted the flourishing of socio-economic investigations based on the *region* as territorial unit of analysis in order to better understand local dynamics driving intra-EU imbalances, which seem to depend greatly on R&D capabilities rather than merely following the conventional north-south (geographical) divide (Cappelen *et al*., 1999). Inter-regional (and inter-country) disparities seem to be mainly due to local innovative capacities embedded in the rates of technological innovation and diffusion (Verspagen and Wakelin, 1997; Fagerberg *et al*., 1997; Fagerberg, 1988; Paci and Pigliaru, 1999b), without, however, disregarding economic, structural and institutional factors. In this light, the need for innovation-based growth in Europe has been recently argued by Fagerberg (1999) in order to reduce and, in the last instance, eliminate cross-border and intra-border disparities.

Trade and technology

However, although relative large streams of (both theoretical and empirical) literature[1] have investigated the relationship between growth differentials and technology, relative little attention has been devoted to the evolution of technology and trade specialisation at subnational level. Having said so, it should be however pointed out that the impact of increased trade specialisation in knowledge-producing and growth-enhancing activities has been recognised by the new models of economic growth (Dowrick, 1997). Yet, as far as the few studies dealing with the relationships between innovation and trade are concerned, the analysis has been mainly conducted at country level. The findings reveal a higher concentration of trade specialisation against a more

dispersed pattern of technological specialisation, although both of them (e.g. trade and technological specialisation) appear to be remarkably stable over time (Amendola *et al*., 1998). The existing literature has also recognised the key role of technology in determining trade flows and international competitiveness at industry and country level (Guerrieri *et al*., 1998). For instance, Fagerberg (1997) has empirically shown that R&D investments appear to impact on exports especially in larger OECD countries and R&D intensive-industries. The crucial character of technology has been also confirmed in sectoral analyses (e.g. Archibugi and Pianta, 1998), where technology seems to account for divergence in sectoral trade specialisation. "Technology gaps" are revealed to remain much wider than "economic gaps" across sectors as, although (European) countries show strong economic convergence, "technology gaps" still exist (*Ibid*.). If this implies that country-specific factors are crucial in shaping national patterns of technological change and comparative advantage, concerns also rise about whether additional progress can take place without increases in domestic innovative activities, which seem to allow reducing the large existing gaps.

The significance of sector-specific factors in promoting trade divergence/convergence has been further emphasised in the context of the EU integration process (Guerrieri and Manzocchi, 1996), as well as in evaluating the EU competitive position in the global arena (Guerrieri and Milana, 1998). In the former case, it has been argued that in principle EU integration can lead to either convergence or divergence as the prevailing of one on another is sector-specific. Industrial sectors characterised by high openness and technological intensity show low degrees of asymmetries in their growth rates across countries (Paci and Rovelli, 1996). Similarly, Guerrieri and Milana (1998) have emphasised the role played by cutting–edge sectors in defining both technological hegemony and the backwardness of the EU in the global arena. The causation mechanism through which the technology factor drives trade flows has been acknowledged by the fact that technology is encompassed in productivity growth which, in turn, affects comparative advantage (Wolf, 1997).

Regional gaps in Italy

Differences in growth differentials, trade and technological sectoral patterns within Europe at national level call for further intra-border investigations. Existing studies have neglected territorial disaggregations more detailed than the national one. On this respect, the novelty of the analysis carried out in this paper lies in the attempt to fill the

gap by focusing on the relationship between technology and trade over time from a geographical perspective centred on the *regional space*. The sectoral evolution of the nature and changes of trade specialisation patterns are investigated and related to regional technological trajectories in the context of the Italian regions.

The different growth rates characterising the Italian regions are far to be an exception in the Union, where heterogeneities across member states are a reflection of domestic socio-economic disparities re-produced over time. In the Italian peninsula, the north-south gap, reflected in the distinction between most advanced and less favoured regions (MARs and LFRs respectively), calls for a better understanding of both structural and technological profiles of the *regional sectoral systems*. Although the north-south divide is largely evident and discussed in the Italian case, the economic geography of the country is somehow more complicated as structural differences exist also within the northern and southern regions. Adopting a highly disaggregation of the Italian national territory up to the level of the *province*, Fabiani e Pellegrini (1997) have provided empirical evidence on divergence of growth differentials between *provinces* over time, although economic development seems to follow trajectories of territorial continuity spinning off from richer to contiguous areas. The crucial role played by spatial proximity and technological diffusion has been also confirmed at regional level by Paci and Pigliaru (1999a), who have shown that the innovation propensity of a region is positive associated to its geographical proximity to highly innovative regions. Further support to internal structural disequilibria of the Italian economy has been provided by other analyses highlighting the divide between the performance of *regional champions* and all other regions (Iammarino *et al*., 1998; Iammarino and Santangelo, 2000). More recently, attempts have been made to provide a broader categorisation of the Italian *regional sectoral systems* (Evangelista *et al*., 2000) by identifying at least three main regional patterns of innovation roughly corresponding to the southern, north-west and north-east regions respectively.

Following this path, the present study attempts to complete the picture by analysing the evolution of trade and technology across regions. Namely, the following hypothesis of whether technology efforts promote internationalisation (understood in terms of international trade) across regions is tested. In attempting to fill the gap in the existing literature, the aim of the study is to provide additional elements which may allow a better understanding of the Italian socio-economic situation as well as to

develop some policy suggestions that can be extended (with due precautions) to other European heterogeneous realities.

3. The data

The data used to analyse the phenomenon discussed in the previous pages are mainly ISTAT (Italian National Institute of Statistics) data at regional and (where available) sectoral level – the only exception being the data on patent application per capita, which are Eurostat data. The regional units identified correspond to the Nomenclature of Territorial Units for Statistics level 2 (NUTS 2), classification adopted by the European Commission.[2] All data refers to the year 1985 and 1996.

The ISTAT trade data refer to the years 1985-1998. For each of the 20 Italian regions, the detailed sectoral export profile disaggregated in 236 sectors has been re-aggregated in 24 broad sectors (see Table A1). This has allowed us to build up a complete and more manageable dataset for the period under analysis for the purpose of the empirical work. On the grounds of these data, an index of revealed comparative advantage (RCA) has been calculated in order to have a clear picture of each regional specialisation across sectors over time. For each year from 1985 to 1998, the index is defined as the share of exports of region (*i*) in sector (*j*) relative to the share of exports of all Italian regions in the same sector:

$$RCA_{ij} = X_{ij}/\Sigma_j X_{ij}/(\Sigma_i X_{ij}/\Sigma_{ij} X_{ij}) \qquad (1)$$

where (*i*) = 1, 2,…., 20 and (*j*) = 1, 2,…, 24. Therefore, X_{ij} is the total exports of region (*i*) in sector (*j*). For ease of exposition, the index has been normalised as

$$RCAC_{ij} = (RCA_{ij} - 1)/(RCA_{ij} + 1) \qquad (2)$$

$RCAC_{ij}$ ranges from –1 to +1: values between 0 and 1 (between 0 and -1) indicate a comparative advantage (disadvantage) of region (*i*) in sector (*j*) relative to Italy as a whole.

4. Dynamics of regional trade specialisation

The dynamics of trade specialisation are analysed for each Italian region by taking the mean of the RCAC values for the period 1985-1987 (the first three years available) and 1996-1998 (the last three years available). The first period is intended to capture the years immediately before the deepening of the EU integration process, while the second refers to the situation after the Maastricht Treaty and, therefore, the commitments to launch a single currency and the recognised importance of the "Europe of regions". The aim of this dynamic analysis is to provide an overview of the major changes in regional trade profiles in order to evaluate, at least in broad terms, whether initial positions of specialisation/de-specialisation have changed over time. The detailed level of analysis also allowed us to identify clearly which are the sectors where changes have occurred: the empirical evidence is discussed by grouping regions by macro areas (i.e. North-West, North-East, Centre and South).[3]

As far as the *North-West* is concerned, for each region the sectoral RCAC values are reported in Figure 1. As expected, within this macro-area Piedmont and Lombardy are the most interesting regional cases as traditional cores of industrial activities in the country. The picture emerging in Piedmont shows several ongoing patterns. First of all, the export specialisation of the region seems to have strongly reduced the traditional comparative advantage in mechanical and mechanical-related sectors with the most evident example in "specialised machinery" - the only exception being "other fabricated metal products" following an inverse trend. This pattern may be explained by a change in FIAT international strategy, as the Italian multinational has substituted its export-based approach with a strategy based on FDI mainly directed to the US and rest of Europe (Cominotti *et al*. 1999). A second pattern may be identified in the small gain of specialisation in "textiles", most likely due to the dynamic industrial districts in the province of Vercelli[4] (Unioncamere *et al*. 1987). More contained is instead the reduction of the regional comparative disadvantage in energy fields. The export specialisation profile of Lombardy has been more widely spread across the 24 sectors and less subjected to dramatic changes in the period under analysis. This confirms the region as the strongest industrial core of the country, where economic agglomeration is mainly due to location- rather than sector-specific factors. Despite the general trend of an average stability in the RCAC index of Lombardy between the first and the second period, a slight increase in "textiles" has occurred most likely as a result of the international development of local systems in the province

of Como (*Ibid*.). Similarly, the export profile of the region has also recorded a change from de-specialisation to specialisation in "photographic, audio and allied industries" and "primary metal products". In Valle d'Aosta, the figures reveal a shift from a specialisation in "tobacco" (which turned into a strong despecialisation at the end of the period) and "wood and lumber products" to "primary metal products", where the remarkable specialisation has become even stronger, and "specialise machinery" (*Ibid*.). The export profile of Liguria has to be interpreted in the light of a process of regional de-industrialisation over time (Omiccioli and Berretta, 1999), as shown by the strengthening specialisation in "agriculture, forestry, fishing and hunting" and by the inability to develop a significant comparative advantage in manufacturing sectors – a notable exception being "tobacco" (Unioncamere *et al*. 1987). The reduction of the export competitiveness of the region in "chemicals" is emblematic of this de-industrialisation process in act. In this context, the upward trend recorded in "primary metals" and "petroleum and coal products" can be explained by the massive public subsidies to these sectors within the framework of the national industrialisation policy, which has inhibited the development of more differentiated kinds of indigenous specialisation as well as a dynamic and innovative network of local enterprises (*Ibid*.).

For the *North-East* regions, the RCAC values are reported in Figure 2. In the later years, a slowdown of the North-East economy has taken place as a result of macro and microeconomic dynamics. Ended the effect of the early 1990s lira devaluation on Italian exports, the Italian participation in the Euro, the increased advantage to de-centralise production towards Eastern European countries and the significance of portfolio investments as a crucial strategy to global competitiveness have provided the coordinates of a new economic phases (Anastasia *et al*., 2000). The North-East regions, which have based their specialisation mainly on the *made in Italy*[5], have seen threatened their international comparative advantage. Within this macro area, Veneto and Emilia Romagna dominate the scene as the most competitive regions. The upward trend in "leather and leather products", "other manufacturing" and "textiles resin, artificial and synthetic fibres" confirms the trade profile of Veneto as the manufacturing region in traditional sectors. The Veneto model, rooted on small- and medium-size enterprises (SMEs) local systems, has based its domestic and international competitiveness on these *supplier-dominated* sectors – using Pavitt's terminology –, characterised by low technology-intensity, high design and marketing differentiation. If the increased export specialisation in "leather and leather products"

may be attributed to the Padova area (Istituto Taglicarne and CENSIS, 1989), the slight decrease in the regional comparative advantage in "clothing and furnishing" may be due to the rising of new regional industrial models based on this traditional sectoral specialisation in other macro-areas of the country, as discussed below. The reduction over time of the export specialisation in "primary metal products" is offset by the strongly increased specialisation in "textiles resin, artificial and synthetic fibres", which is closely related with the sectoral strengths of the local industry. As far as Emilia Romagna is concerned, a "rationalisation" of the region's export pattern seems to emerge. Traditionally, the economic system of the region has been characterised by a specialisation in industrial activities of second transformation, such as mechanical, food and garments sectors. At a first glance at the figures, it appears that the export advantage of the region has gradually moved away from food-related sectors (e.g. "drinks" and "tobacco") towards mechanical sectors (e.g. "specialised machinery" in which the decrease of the export comparative disadvantage may be attributed to the area of Modena)[6] and "non-ore minerals", which, including ceramics production, is one of the leading fields of the production profile of the region, with several notable industrial districts (e.g. Sassuolo) (Tomasini, 1989). With regards to this shift in the Emilia export pattern, it is important to remind that technological progress embodied in machinery and equipment represents a significant source of technological innovation in Italian manufacturing in general, and the most important source for many SMEs operating in *supplier-dominated* sectors which do not show an autonomous innovative capacity (Santarelli *et al*., 1991; Guerrieri and Iammarino, 2001). This seems to be confirmed by the reduction over time of the region comparative disadvantage in garments (e.g. "clothing and furnishing") (Istituto Tagliacarne and CENSIS, 1989; Bigarelli, 2000). Friuli shows a small shrinking of competitiveness in "wood and lumber products" and "paper and allied industries", which have historically been the sectors driving the economy of Udine and Pordenone, as well as a drastic development of its comparative advantage in "tobacco". Flourished after the crisis of the textiles industry in the region, the wood industry has found its major export market in Central and Eastern Europe. The opportunities opened in this relatively new market have re-launched Friuli from a peripheral region to the door to the new Europe (Schenkel, 2000). However, the recent slowdown of the economy of these new foreign markets seems to have negatively affected the export performance of the region in the most recent years. In Trentino, the specialisation of Bolzano drives the strong

comparative advantage in “drinks”, which has been slightly reduced in the second period under analysis. Conversely, the region has gained a remarkable comparative advantage in “photographic, audio and allied industries”, “printing publishing and allied industries”, reinforcing also that in “paper and allied industries”.

In the *Centre*, the situation in terms of regional sectoral comparative advantages is sketched in Figure 3. In this context, the export profile of Lazio appears rather different from the other regions of this macro-area. The specialisation of Latina seems to account for the export profile of the region in chemicals and chemical-related sectors (i.e. “photographic, audio and allied industries”), where Latina is a leading province within the regional context. Similarly, if the presence of FIAT in Cassino accounts for the regional comparative advantage in “means of transport”, the increased export specialisation in “specialised machinery” reflects the competitiveness of the provinces of Frosinone and Rome in foreign markets. Conversely, the region has experimented a reduction of the advantage in “other manufacturing” and a strengthening of “tobacco” over time. The trend emerging in Tuscany confirms the specialisation of the region in traditional sectors, mainly of the *made in Italy* type, such as “textiles”, due to the presence of one of the most quoted Italian district, that of Prato. A growth in the region’s comparative advantage in food-related products and “leather and leather products” as well as in “paper and allied industries” is recorded over time. These sectoral trends may be attributed to expertise developed in local systems within the region such as Lucca in food-related fields and Florence in leather products. The decrease of specialisation in “non-ore minerals” may be also strictly linked to local dynamics as this is a sector of major specialisation of Massa Carrara. The situation is slightly different as far as Umbria is concerned. In the region, food-related sectors (linked to the confectionary industry) – particularly “non-edible products” and “tobacco” -, and “primary metal products” are driving the regional trade profile by compensating for the slight reduction in export competitiveness in “textiles resin, artificial and synthetic fibres”, which however remains a point of strength in the region’s export pattern, and “other fabricated metal products”, which has become a disadvantaged sector over time. In Marche, the slight reduction of the strong specialisation in “clothing and furnishing” in the later period has been accompanied by a further gain of competitiveness in “wood and lumber products”, “rubber products” and “machinery and equipment” (most probably due to the development of the area of Pesaro and Urbino, and Ancona respectively (Paradisi, 2000)). This region has been

one of the most dynamic of the North-East-Centre (NEC) area by taking advantage from the devaluation of the lira in the earlier 1990s as well as from the trade opening with Central and Eastern European countries (Simonella, 1999). By relying on design and quality as major elements of competitiveness (Omiccioli, 1999), local enterprises have targeted particular trade partners according to their sectoral preferences. Within this framework, the decrease in export advantage in clothing, for instance, may be explained by the crisis of the Russian economy, which has heavily impacted on Marche exports of garments (Balloni and Iacobucci, 2000). From the first to the second period under analysis, Abruzzo has experimented a general weakening of comparative advantages in sectors typically driving its export profile (e.g. "paper and allied industries", "non-ore mineral" and "means of transport", all of them, however, still representing points of regional strength), while augmenting over time its competitiveness in international markets in "rubber products", "specialised machinery" and "other manufacturing" (the latter two sectors showing despecialisation in the first period considered). The specialisation of Molise has instead diversified, particularly towards "clothing and furnishing" and "textiles", which has gained a comparative advantage over time. This may suggest a relative transformation of the regional economy towards a more *made in Italy* specialisation as illustrated by the development of the Campobasso area in the strengthening sectors.

As far as the *South* is concerned, the dynamics of each region's comparative advantage are drawn in Figure 4. In Campania, a major trend has taken place between the mid-1980s and the mid-1990s, as shown by the drastic decline in trade specialisation in "photographic, audio and allied industries". This decline seems to reflect a structural change in the local production profile characterised by a strong specialisation in chemical-related sectors, mainly due to the 1970s model of industrialisation. As illustrated by the figures, in the later period the specialisation profile of the region has mildly moved toward sectors which have traditionally characterised the Italian comparative advantage (e.g. "leather and leather products", "specialised machinery" and "textile resin, artificial and synthetic fibres"). The trade profile of Puglia reveals a consolidation of the local industrial structure characterised by clusters of SMEs, mainly in the Bari area. Food-related sectors and sectors defining the "fashion system" are the fields leading the specialisation of these clusters. Nonetheless, within the broad food sectors the figures illustrate a reduction of competitiveness in "drinks" and an strengthening in "tobacco", while recording an

upward trend in fashion-related sectors (e.g. “leather and leather products” – where the comparative disadvantage of the region has been sensibly reduced - and “clothing and furnishing”). This seems to suggest a development of the regional export specialisation toward a more traditional model as the one of the NEC area. However, a substantial difference exists between the NEC area and Puglia competitiveness. The latter is a relatively more price-based competitiveness, which has allowed the region to export successfully toward EU countries. The former is instead a competitiveness based to a larger extent on quality and product differentiation, both of which have allowed the historical industrial districts to avoid the competition of the Newly Industrialised Countries (NICs) in the international scenario. If this is true generally speaking, as far as “leather and leather products” and “clothing and furnishing” are concerned, a growing innovative industrial network has recently emerged in the area of Santeremo and Altamura (Belussi, 1999). Conversely, the picture emerging from Basilicata and Calabria is far less dynamic. The former has further reduced its comparative advantage in agricultural products and “textile resin, artificial and synthetic fibres” (where the trade specialisation of the region turned into a despecialisation), while incrementing its export competitiveness in “means of transport”. These figures should be interpreted within the framework of the national policy for the industrialisation of Mezzogiorno, based on the localisation of subsidised private investments in depressed areas. Therefore, the increased competitiveness of Basilicata exports in “means of transport” is most likely due to the early-1990s establishment of a FIAT plant in Melfi (Svimez, 1993). As far as Calabria is concerned, the regional competitiveness in “agriculture, forestry, fishing and hunting” has been strengthened. However, the agricultural character of the regional economy seems to be somehow counterbalanced by an increasing specialisation in “machinery and equipment” and “rubber products”. In both Sicily and Sardinia, “petroleum and coal products” appears to be the sector driving the comparative advantage of the two regions. If in Sicily the high specialisation in this sector over time may be attributed to the petrol-chemical pole of Gela – generated by the clustering of large Italian and foreign companies –, in both regions this sectoral advantage can be also explained as a result of the old model of basic industrialisation[7] which has heavily marked the Southern production system (Unioncamere *et al.*, 1987). Conversely, the growing competitiveness of Sicilian exports in “drinks” is mostly likely due to the local production of international established wines in the province of Trapani.

5. Internationalisation and technology effort

After having sketched the sectoral strengths and weaknesses of Italian regional export patterns in the previous section, we turn to give some support to the hypothesis of whether the technological effort (R&D) impacts on internationalisation (INT) by means of a simple regression analysis across Italian regions, which can be formalised as follows

$$INT_i = \alpha + \beta R\&D_i + \varepsilon \qquad (3)$$

where (i) = 1, 2, ….., 20;
INT is defined as the ratio between export and total value added in manufacturing for each region (i);
R&D indicates the share of R&D expenditures of each region (i) relatively to Italy as a whole, adopted as a proxy for technology effort.

Equation (3) was estimated for the years 1985 and 1996 in turn. As reported in Tables 1 and 2, the association inexistent in 1985 turned to be statistically significant in 1996. This might provide some support to a structural change in the industrial competitiveness of the Italian regions, which, playing on their traditional sectoral strengths (discussed in the RCAC analysis), have targeted product and process quality improvements as a means of competition. In fact, as summarised by Archibugi and Michie (1998), process innovations reduce production costs and output prices, thus increasing competitiveness, while (minor) product innovations improve the quality of the commodity. The role played by traditional sectoral strengths in this process is confirmed by the increasing weakness in scale economies sectors (characterised by large firms and strong economies of scale) for Italy as a whole (Ferrari *et al*., 1999). This may suggest that the change in the industrial competitiveness of Italian regions encompasses a re-structuring of traditional sectoral strengths rather than a move toward different sectors, as confirmed by the fact that Italy is the only among the major European member states to lag behind in trade of high-tech goods (*Ibid*.).

Several factors can be recognized as determinants of this phenomenon. First of all, the fast pace of technological change as well as the deepening of the European

integration process during the period under analysis have called for a strengthening of industrial competitiveness in foreign markets, which seems to have been pursuit *via* an increase in R&D (and more generally, in innovative) efforts. As argued by Onida (1998), the recent evolution of markets and technology has raised the needs of strengthening the Italian specialisation model in order to avoid that domestic constrains (e.g. small size of firms in the industrial districts, limited applied research, negative perception of "going abroad"[8]) may affect Italian competitiveness. Strictly linked to the first, a second factor should be also acknowledged. At the national and community level, the concern on innovation has raised over time, as demonstrated by the proliferation of R&D policies in the decade under consideration and the growth of incentives to locate R&D centres in depressed areas. Thus, the proliferation of community and national stimulation to increase R&D efforts reveals the recognised significance of innovative capacity to boost competitiveness. Third, due to the recognition of innovation as a major determinant of successful economic performances, firms are more akin to taken into account innovation aspects in their strategy. A major outcome of this may be identified in the development of networks between firms and research institutes as well as in the general (although still contained by comparison with other European countries)[9] increase in technology effort.

Considering the inter-regional sectoral differences in trade specialisation, the result obtained in the regression analysis may be read in the frame of an average move over time towards regional trade patterns which, strictly linked to local expertise built up over time, are likely to be characterised by a higher innovative and R&D content. This may promote medium- and long-run convergence/divergence processes, as the greater R&D content of exports is clearly not growing to the same extent across regions. In fact, although the R&D effort has, on average, doubtless increased between 1985 and 1996, cross-regional inequalities still exist. This argument is clearly illustrated in Figure 5 plotting internationalisation (INT_{96}) against technological effort ($R\&D_{96}$) and highlighting the position of each region. Lombardy and Lazio are the regions showing both high INT and R&D effort. However, it should be specified that in the first case the position of the region is clearly explained by local agglomeration economies and dynamic systemic interactions which define Lombardy as the engine of the Italian economy. In the case of Lazio, instead, the overplay of institutional factors should be taken into account when evaluating the position of the region with reference to the relationship between the two variables considered. At the opposite end, we

found Southern and Central regions, showing low performance in both INT_{96} and $R\&D_{96}$.[10] Because of the high reliability of the export of these regions on European markets, the drastic decline of the European demand in 1996 strongly affected these regional economies (ISTAT, 1996, 1997). Similarly, those regions have been traditionally characterised by low R&D efforts as confirmed by the plotting. In this context, Sicily and Sardinia represent an exception by recording a relatively above average degree of internationalisation, although still low technology effort. All other Italian (mainly North-East and North West) regions show an average pattern to different extents. Therefore, although structural processes are taking place in the Italian regional scenario, geographical hierarchies still exist in terms of trade and technological dimensions. In this context, the remaining of the analysis is dedicated to examine cross-regional differences by identifying broad regional profiles.

5.1 Regional profiles of production structure

In order to explore further the results of the regression analysis, our investigation turns to examine the possibility of identifying homogeneous regional profiles in terms of production structure in the later year considered. For this purpose, a number of indicators, classified in three broadly defined groups (see Table A3), have been considered. Given the complexity and the multivariate nature of the aspects we want to capture, a principal component analysis (PCA) was carried out. The components extracted were then used to classify regions showing similar characteristics in terms of industrial structure and productivity. The final aim is to look at the pattern followed by internationalisation and technological effort across these distinctive regional profiles.

As far as the indicators used are concerned, a first set is related to the economic structure of the regions. These indicators measure the significance of industry, services and agriculture in the Italian regions in terms of value added and investments. A proxy for labour productivity is also included as strictly linked to this aspect, while expenditures for public works may be understood as a proxy for infrastructures. A second group of variables intends to capture the innovative dimension of the Italian regions by measuring the share of R&D expenditures of public research institutes and firms, the number of patent applications as well as of students with a college degree. Finally, a third set of variables refers to the trade dimension by taking into account the significance of export per employees and internationalisation. On the grounds of the

correlation matrix reported in Table 3, six variables[11] were included in the PCA. In fact, as illustrated in Table 3, the variables concerning service and agriculture sectors show suspiciously high linear correlations, revealing a strong similarity between each other and preventing from including them in the analysis. The same applies to the relationship between PUBEXP and EXPEMP. STUDENT was instead dropped because scarcely correlated with all other variables. Although INT passed the selection process, it was dropped in the final results for the sake of simplicity. The reasons for doing so were twofold: first, this variable characterised a further component related to trade whose explained variance was found to be negligible; second, no additional information would have been provided by this further component in terms of industrial structure and productivity - which is the aspect the analysis aims to capture. Therefore, the PCA was run on all remaining variables. The tests performed on the correlation matrix of the selected variables provide support to the significance of the analysis[12] (see Table 4 and Figure 6), which allowed to extract two Components explaining almost 80% of the total variance (see Table 5).

As far as the interpretative meaning of the two components is concerned (see Table 6), the **first component** has been understood as related to the performance of the regional *industrial structure* in terms of value added and investments in manufacturing (AVIND and INVIND respectively), and patent applications (PATENT). All these variables capture the dynamism of the region in terms of its production activity. If AVIND provides a measure of the regional industrial production of the region, INVIND and PATENT reveal some major aspects of the industrial structure in terms of regional entrepreneurship and sectoral specialisation. The **second component** has been interpreted as related to the performance of the regional *R&D-based productivity* as a result of the high loadings of variables such as GDP per unit of labour (GDPUL) and R&D expenditures of public research institutes and firms (R&DEXPPRI and R&DEXPFIRM respectively). R&D efforts by firms and public research institutes are likely to generate an increase in productivity due to greater innovative contexts than to lower production costs, as traditionally maintained (e.g. cheap labour, subsidies, etc.).

The Italian regions were then grouped on the basis of an agglomerative hierarchical cluster analysis using the two components extracted.[13] The position of each regional profile with respect to the two components is shown in Figure 7. The vertical axis in the figure measures the *industrial structure*, while the horizontal axis measures the *R&D-based productivity*. Seven profiles were identified.

Dynamic industrial and technological regions

A first cluster – located at the top-right of Figure 7 – identifies *industrial and technological dynamic regions*, characterised by both high R&D-based productivity and industrial dynamics. It is not by chance that the only Italian region entering in this profile is Lombardy. This underlines once again the structural difference between Lombardy and all other Italian regions, whose economies are strongly rooted in some specific sectoral expertises (e.g. *made in Italy*, mechanicals and related fields, etc.) or lagging-behind. Conversely, Lombardy represents the industrial core of the country attracting economic activities in a broad spectrum of sectors and devoting large resources to R&D by firms and public research institutions. The robust industrial structure of the region is reflected in the presence of large and medium-size firms, greater industrial productivity rate and a concentration of very high-technology sectors (Camagni and Capello, 1997). The presence of large firms and of advanced industries also explains the high number of patent applications, as formal innovation can be either afforded by large firms or occurred when the pace of technological change is high. This mix of factors together with excellent infrastructures and proximity to consumers has created a dynamic industrial economy. Similarly, the presence of established Universities and research institutes together with the significance of design and engineering activities provide relevant innovative sources. In fact, the region records high R&D expenditures generating an innovation rate above the national average and a high propensity to innovate (*Ibid*.), impacting on the competitiveness of the regional industrial structure by means of dynamic spillovers.

Dynamic industrial regions

Piedmont and Emilia-Romagna are the two regions composing the second regional profile identified and characterised by high industrial structure and medium R&D-based productivity. Both regions have traditionally showed an industrial structure strongly oriented toward mechanical sectors, which represent a significant source of technological innovation in Italian manufacturing in general. However, although the technological progress embodied in this field accounts for the most important source for many SMEs operating in *supplier-dominated* sectors, the productivity of the two

regions is only mildly determined by technology efforts. This can be attributed to the regions' sectoral specialisation, as the innovative effort is usually greater when high-technology industries are at work. Therefore, the main feature characterising the two regional economies can be found, as traditionally pointed out, in their industrial systems, showing a dynamic structure in terms of industrial production and enterpreneurship.

Traditional industrial regions

A third cluster encompasses *traditional industrial regions*, which have been identified as Veneto, Friuli, Tuscany and Liguria. Common features of these regions are their medium industrial and medium technological dynamics - the exception being Liguria, which is going trough a process of de-industrialisation as discussed in the analysis of the regions' cross-sectoral RCAC over time. Nonetheless, Liguria can be place in this context when considering its traditional industrial (although declining) straightness in building and equipment. Conversely, Veneto, Friuli and Tuscany have built their competitiveness on an industrial structure based on the *made in Italy* specialisation. In terms of industrial structure, all three regional economies are oriented towards *made in Italy*-type sectors (e.g. textiles, leather products and furnishing); all of them are characterised by low intensive technology, high design and market differentiation; and all three are rooted on SMEs local networks. As far as the regional productivity is concerned, this is dictated by a highly qualified labour force more than R&D efforts, as the external reliance on technical services and support by local SMEs reveals.

Emerging industrial regions

A fourth regional profile classifies regions characterised by medium industrial and low technological dynamics. Labelled as *emerging industrial regions*, Abruzzo, Marche, Basilicata and Umbria are the regions where new local systems of production have recently developed on the lines of the more traditional industrial districts of the North-East. Characterised by networks of SMEs operating mainly in *made in Italy* sectors, these regions have target a price-based competitiveness rather than a competitive advantage based on either quality and product differentiation – as the regions classified in the previous profile – or innovation. If their relatively new emergence as active

industrial areas explains the definition of their industrial structure as medium dynamic, this kind of competitive strategy justifies their low R&D-based productivity.

Laid-back regions

All regions (but Trentino, located in the North-East, and Molise, located in the Centre) grouped under this profile are Southern regions. All of them (Sardinia, Molise, Trentino, Calabria, Sicily, Puglia and Campania) are characterised by low technological and industrial dynamics, thus labelled as *laid-back regions*. Besides some localised exceptions (e.g. the area of Bari), all these regions have suffered from structural problems that have prevented the take-off of the local development. In fact, characterised by the lack of general and technological infrastructures, they have failed to create an industrial structure rooted on local expertise and networks. Conversely, regional profiles have shown a strengthening of their specialisation in traditional and slow-growth sectors as a result of a worsening of structural factors (e.g. lack of infrastructures, state-dependence, public inefficiency, lack of dynamic networks of SMEs, dependence on innovation from other actual innovation systems) (Evangelista *et al*., 2000; Guerrieri and Iammarino, 2001).

Two special cases

As depicted by Figure 7, two additional profiles, defined as special cases, were identified: *Lazio*, which scores very high on Component 2 (i.e. R&D-based productivity) most probably as a result of institutional factors determining agglomeration of research institutes in Rome; and *Valle d'Aosta*, whose position with respect to the two components extracted seems to be affected by the variable GDPUL (encompassed in Component 2), which is strictly linked to the size of the region. Therefore, these two clusters will be dropped from the analysis further carried out below.

For each regional profile (but Lazio and Valle d'Aosta), Figure 8 plots the average change in R&D and INT calculated between 1985 and 1996. At a first glance at the Figure, it can be inferred that clusters performing well over time in R&D are those recording consistent positive increases in INT. However, besides the balanced scenario

shown by the profile of *Dynamic industrial and technological regions* (i.e. Lombardy), the situation is rather uneven for the other regional profiles in terms of internationalisation and technological effort.

All regional profiles record an increased in R&D effort, the most remarkable being the one of *Laid-back regions* followed by *Emerging industrial regions*. This performance may be due to the first effects of the change of the policy approach towards the development of Mezzogiorno as well as to other factors intervened in the meanwhile. In fact, the mid-1990s recorded massive foreign investments in the Mezzogiorno, as compared to the rest of the country. As acknowledged by Mariotti and Mutinelli (1999), foreign acquisitions of participations in privatised or formerly public enterprises concerned 87 production plants located in the whole Italian territory and 23 located in the South. Significant contributions came from minority participations (e.g. Essar in Ilva Laminati Piani) and from equal joint ventures (e.g. Telsi between STET (Telecom) and Siemens). Yet, in terms of technological efforts, *Dynamic industrial regions* show a consistent increase. In this case the role played by mechanical equipment sectors as source of innovation for other related fields may provide an explanation. The lowest increase in R&D effort is recorded by *Traditional industrial region*, which also show a negative change in INT. If the competitiveness based on market differentiation and design explains the contained increase in technological efforts in these regions, the decrease in INT may be attributed to the de-industrialisation process experienced by Liguria as well as by the crisis of the local industry in Friuli (both discussed in section 4). The most contained growth in INT is the one recorded by D*ynamic industrial regions* maybe attributable to FIAT strategy discussed in section 4 (RCAC analysis). Conversely, *Laid-back regions* together with D*ynamic industrial and technological regions* are those driving the average change in INT. The reasons behind these figures are obviously different. In the latter case, we are taking into consideration the traditional industrial core of the country. As far as *Laid-back regions* are concerned, the meanwhile economic situation should be evaluated. In fact, during the mid-1990s the exports of these regions went through a greater growth as a result of the recovering of European markets (Istat, 1996, 1997).

6. Conclusions

Given the little attention dedicated to the relationship of trade and technology at detailed territorial levels of analysis by the existing (theoretical and empirical) literature, the present study has attempted to fill this gap by carrying out an empirical investigation in the context of the Italian regions. The existing studies on this topic have explored this relationship at country level. Conversely the present study has attempted to make a further step by taking into consideration a territorial disaggregation more detailed than the national one. The choice of the region as spatial unit of analysis is due to the recognised significance of the local space for the purpose of global competitiveness, steaming from localised knowledge spillovers and geographical concentration of economic activity. In fact, within the EU area the existence of *cross-border* imbalances has been understood in terms of *intra-border* inequalities. In this scenario, the uneven socio-economic conditions of the Italian regions are emblematic of a common phenomenon across member states to different extents.

Due to the wide acknowledged significance of technology as a major determinant of internationalisation (i.e. international trade), the hypothesis of whether the technological effort impacts on internationalisation has been tested. The results of the regression analysis suggest a structural change in the industrial competitiveness of the Italian regions between the mid-1980s and the mid-1990s, when their technology efforts seem to account greatly for their internationalisation. This patter is far to be generated by a major move towards high-tech sectors (where the Italian performance is still weak). Conversely, it has been argued that Italian regions seem to have played on their traditional sectoral strengths targeting product and process quality improvements. This strategy has led to regional trade patterns characterised by a higher R&D content, which allowed a growth in international competitiveness. However, this phenomenon has taken place across regions to different extents, confirming *leading* and *lagging-behind* positions. The uneven development of this phenomenon across regions has been confirmed by the identification of a number of regional profiles of the production structure, showing different patterns of internationalisation and technology over time.

References

Amendola, G., Guerrieri, P. and Padoan, C. P. (1998) "International patterns of technological accumulation" in Archibugi, D. and Michie, J. (eds.) *Trade Growth and Technical Change*. Cambridge University Press.

Amendola, G., Guerrieri, P. and Padoan, C. P. (1992) "Specializzazione commerciale e specializzazione tecnologica: un confronto internazionale" in Boitani, A. e Cicciotti, E. (eds.) *Innovazione e Competitività nell'Industria Italiana*. Il Mulino.

Anastasia, B., Gambuzza, M. and Rasera, M. (2000) "La strana "crisi" dell'occhialeria bellunese: tra globalizzazione delle imprese maggiori e difficoltà della produzione diffusa". *Piccola Impresa/Small Business*, Vol. 13, No. 2, pp.41-57.

Archibugi, D. and Michie, J. (1998) "Trade, growth and technical change: what are the issues?" in Archibugi, D. and Michie, J. (eds.) *Trade Growth and Technical Change*. Cambridge, Cambridge University Press.

Archibugi, D. and Pianta, M. (1998) "Aggregate convergence and sectoral specialisation in innovation: evidence for industrial countries" in Archibugi, D. and Michie, J. (eds.) *Trade Growth and Technical Change*. Cambridge, Cambridge University Press.

Balloni, V. and Iacobucci, D. (2000) "Classifica delle principali imprese manifatturiere marchigiane: anno 1998". *Economia Ma*rche, pp. 31-75.

Becattini (2000) "Dal "miracolo economico" al 'made in Italy'". *Economia Ma*rche, No. 1, pp. 7-30.

Bigarelli, D. (2000) "Strategie commerciali e internazionalizzazione produttiva di Carpi negli anni '90". *Piccola Impresa/Small Business*, No. 2, pp. 23-39.

Belussi, F. (1999) "Path dependency vs. Industrial dynamics: an analysis of two heterogeneous districts" paper presented at the European Meeting on Applied Evolutionary Economics, Grenoble.

Camagni and Capello (1997) "Innovation and performance of SMEs in Italy: the relevance of spatial aspects". *ESRC Centre for Business Research, University of Cambridge Working Paper*, No. 60.

Cappelen, A., Fagerberg, I. and Verspagen, B. (1999), "Lack of regional convergence". Paper presented at the EAEPE Annual Conference, Prague.

Cominotti, R., Mariotti, S. and Mulinelli, M. (1999) *Italia Multinazionale 1998*. Roma; Documenti Cnel.

Dowrick, S. (1997) “Trade and growth: a survey” in Fagerberg, J. *et al*. (eds.) *Technology and International Trade*; Cheltenham, Edward Elgar.

Eurostat (1995) *Nomenclature of Territorial Units Statistics*. (Luxembourg).

Evangelista, R., Iammarino, S., Mastrostefano, V. and Silvani, A. (2000) “ Looking for regional systems of innovation. Evidence from the Italian innovation survey”, ISRDS-CNR Technical Report, November.

Fabiani, S. and Pellegrini, G. (1997): “Convergenza e divergenza nella crescita delle province italiane”. Convegno Banca d’Italia “Ricerche Quantitative per la politica Economica”, Perugia.

Fagerberg, J. (1999) “The need for innovation-based growth in Europe”, *Challenge*, Vol. 42, No. 5, pp. 63-79.

Fagerberg, J. (1997) “Competitiveness, scale and R&D” in Fagerberg, J., Hansson, P. Lundberg, L. and Melchior, A. (eds.) *Technology and International Trade*. Cheltenham, Edwar Elgar

Fagerberg, J. (1994) “Technology and international differences in growth rates”. *Journal of Economic Literature*, Vol. XXXII, pp. 1147-1175.

Fagerberg, J. (1988) “International Competitiveness”, *The Economic Journal*, Vol. 98, pp. 355-374.

Fagerberg, J. and Verspagen, B. (1996), “Heading for divergence? Regional growth in Europe reconsidered”, *Journal of Common Market Studies*, Vol. 34, No. 3, pp. 431-448.

Fagerberg, J., Verspagen, B. and Caniëls, M. (1997), “Technology, growth and unemployment across European regions“, *Regional Studies*, Vol. 31, No. 5, pp.457-466.

Ferrari, S., Guerrieri, P., Malerba, F., Mariotti, S. and Palma, D. (1999) *L’Italia nella Competizione Tecnologica Internazionale*. FrancoAngeli.

Guerrieri P. and Iammarino (2001) “SMEs, technology and internationalisation in the Italian Mezzogiorno”, *mimeo*.

Guerrieri, P., Maggiolini, P. and Zezza, G. (1998) “The dynamics of international competitiveness: first results from an analysis at the industry level”, *Labour*, Vol. 12, o. 2, pp. 239-253.

Guerrieri, P. and Manzocchi, S. (1996) “Patterns of trade and foreign direct investment in European manufacturing: ‘convergence’ or ‘polarisation’?”. *Rivista Italiana degli Economisti*, Vol. 1, No. 2, p. 213-231.

Guerrieri, P. and Milana, C. (1998) “High-technology industries and international competition” in Archibugi, D. and Michie, J. (eds.) *Trade Growth and Technical Change*. Cambridge, Cambridge University Press.

Iammarino, S., Prisco, M. R. and Silvani, A. (1998) “The geography of production and innovation: how regional “styles” play in the global scenario”. *The Regional Science Review*, Vol. 18.

Iammarino S. and Santangelo, G. D. (2000) “Foreign Direct Investment and regional attractiveness in the EU integration process: some evidence for the Italian regions. *European Urban and Regional Studies*, Vol. 7, No. 1, pp. 5-18.

ISTAT (1996) *Rapporto Annuale*.

ISTAT (1997) *Rapporto Annuale*.

Istituto Tagliacarne and Censis (1989) *Localismi e Nuove Strategie d’Impresa*. FrancoAngeli.

Mariotti, S. and Mutinelli, M. (1999) “Gli investimenti diretti esteri nel Mezzogiorno: il passato e le tendenze attuali”, *L’Industria*, No. 2, aprile-giugno, pp. 263-274.

Neven, D. and Gouyete, C. (1995) “Regional Convergence in the European Community”, *Journal of Common Market Studies*, Vol. 34, No. 3, pp. 47-65.

Omiccioli, M. (1999) “I distretti industriali di Pesaro, Civitanova Marche e Ascoli Piceno”. *Economia Marche*, No. 2, 63-65, Agosto.

Omiccioli M. e Berretta, E. (1999) “Istituzioni, incentivi e crescita economica: il caso della Liguria”. *Economia Marche*, No. 2, 149-177, Agosto.

Onida, F. (1998) “L’Industria Italiana in un Contesto aperto”. *CESPRI Working Paper* No. 104.

Paci, R. and Pigliaru, F. (1999a) “Diffusione tecnologica, *spillover* spaziali e crescita. Un’applicazione al caso delle regioni europee”. Università di Cagliari e CRENoS *mimeo*.

Paci, R. and Pigliaru, F. (1999b) “Technological catch-up and regional convergence in Europe”. CRENoS Working Paper No. 99/9.

Paci, R. and Rovelli, R. (1996) “Do trade and technology reduce asymmetries? Evidence from manufacturing industries in the EU”. *CRENos Working Paper* No. 96/5.

Paradisi, M. (2000) “Distretti, reti, sistemi locali: il caso delle attività meccanica nell’area a sud di Ancona”. *Economia Ma*rche, No. 1, pp. 135-159.

Santarelli E., Sterlacchini A., Quaglia F. (1991), “Investimenti in macchine e innovazione nelle piccole e medie imprese”. *L’Industria*, February, 289-318.

Schenkel, M. (2000) “Innovazione, competitività e internazionalizzazione: il caso di un sistema regionale”.*Piccola Impresa/Small Business*, Vol. 2, pp. 59-77.

Simonella, I. (1999) “L’esportazioni delle marche verso i paesi dell’Europa orientale: una lettura per poli strategici”. Economia Marche, No. 2, pp. 131-148, Agosto.

Svimez (1993) *L’Industrializzazione del Mezzogiorno: la FIAT a Melfi*. Il Mulino.

Tomasini, S. (1989) *Politiche macroeconomiche e comportamenti d’impresa: il caso dell’Emilia Romagna*. Il Mulino.

Unioncamere, Istituto Guglielmo Taglicarne and Censis (1987) *Rapporto 1987 sullo stato delle economie locali*, FrancoAngeli.

Verspagen, B. and Walkein, K. (1997) “Technology, employment and trade perspectives on European integration” in Fagerberg, J., Hansson, P. Lundberg, L. and Melchior, A. (eds.) *Technology and International Trade*. Cheltenham, Edwar Elgar

Wolf, E. N. (1997) “Productivity growth and shifting comparative advantage on industry level“ in Fagerberg, J., Hansson, P., Lundberg, L. and Melchior, A. (eds.) *Technology and International Trade*. Cheltenham, Edwar Elgar

Table A1 - sectors denomination

1	Agriculture, forestry, fishing and hunting
2	Mining
3	Food products
4	Non-edible products and butchery residuals
5	Drinks
6	Tobacco
7	Leather and leather products
8	Textiles
9	Clothing and furnishing
10	Wood and lumber products
11	Paper and allied industries
12	Printing, Publishing and allied industries
13	Photographic, audio and allied industries
14	Primary metal products
15	Machinery and equipment
16	Specialised machinery
17	Means of transport
18	Other fabricated metal products*
19	Non-ore minerals**
20	Chemicals
21	Petroleum and coal products
22	Textile resin, artificial and synthetic fibres
23	Rubber products
24	Other manufacturing

* excluding machinery and transport equipment
** excluding oil and coal products

Table A2 - Italian regions (NUTS 2) aggregated by macro-areas (NUTS 1)

macro-area (NUTS 1 level)	*regions (NUTS 2 level)*
North-West	Piedmont Valle d'Aosta Lombardy Liguria
North-East	Trentino-Alto Adige Veneto Friuli-Venezia Giulia Emilia-Romagna
Center	Tuscany Umbria Marche Lazio Abruzzo Molise
South	Campania Puglia Basilicata Calabria Sicily Sardinia

Table A3 - Lists of variables preliminary included in the principal component analysis

Broadly defined groups of indicators	*Legend of acronima*	*Proxy*
Economic structure	*AVIND=SHARE OF MANUFACTURING*	*(Value added of goods for sale / Total value added)*
	AVSERV=SHARE OF SERVICES	(Value added of services for sale / Total value added)
	AVAGR=SHARE OF AGRICULTURE	(Value added of agriculture / Total value added)
	INVIND=INDUSTRY INVESTMENTS	*(Investments in industry / Total Investments)*
	INVSER=SERVICE INVESTMENTS	(Investments in services / Total Investments)
	INVAGR=AGRICULTURE INVESTMENTS	(Investments in agriculture / Total Investments)
	GDPUL=EMPLOYMENT PRODUCTIVITY	GDP/Total units of labour
	PUBEXP=EXPENDITURE FOR PUBLIC WORKS (per capite)	Public expenditure for public works / Resident population
Technological dimension	*PATENT=PATENT APPLICATIONS (per capite)*	*Patent applications / Resident population *1000*
	*R&DPRI=SHARE OF R&D EXPENDITURE OF PUBLIC RESEARCH INSTITUTES**	*(R&D expenditures from public research institutes / Total R&D expenditures)*
	R&DFIRM=SHARE OF R&D EXPENDITURE OF FIRMS	*(R&D expenditures from firms / Total R&D expenditures)*
	STUDENT=LICENSED STUDENTS	Student with a college degree / Enrolled students
Trade dimension	EXPEMP=EXPORT PER EMPLOYEE	Export / Total employees in manufacturing
	EXPVA=INTERNATIONALISATION	Export / Total value added in manufacturing

*Including Universities
***Italics* denotes variables used in the PCA

Table 1 - Results of the regression in equation (1) for 1985

Dependent variable INT_{85}

	Coefficient	Standard Error	t-Ratio	
$R\&D_{85}$	33,55	1870,29	0,02	
Intercept	669,21	192,88	3,47	***
R^2	1,8E-05			
No. of observations	20			

***significant at 1% level

Table 2 - Results of the regression in equation (1) for 1996

Dependent variable INT_{96}

	Coefficient	Standard Error	t-Ratio	
$R\&D_{96}$	30,77	8,22	3,74	***
Intercept	463,07	63,61	7,28	***
R^2	0,44			
No. of observations	20			

***significant at 1% level

Table 3 - Correlation matrix of the variables preliminary included in the PCA

	AVAGR	AVIND	AVSERV	INVAGR	INVIND	INVSERV	PATENT	GDPUL	PUBEXP	STUDENT	R&DEXPPPRI	R&DEXPFIRM	INT	EXEMP
AVAGR	1,00	-0,46	-0,65	0,74	0,12	-0,43	-0,52	-0,80	0,69	-0,21	-0,52	-0,53	-0,52	-0,64
AVIND	-0,46	1,00	-0,19	0,15	0,64	-0,40	0,84	0,54	-0,65	0,32	0,06	0,59	0,09	0,58
AVSERV	-0,65	-0,19	1,00	-0,89	-0,54	0,75	0,07	0,58	-0,26	0,27	0,54	0,16	0,48	0,36
INVAGR	0,74	0,15	-0,89	1,00	0,53	-0,74	-0,05	-0,54	0,25	-0,11	-0,52	-0,20	-0,53	-0,27
INVIND	0,12	0,64	-0,54	0,53	1,00	-0,79	0,63	-0,04	0,04	0,18	-0,06	0,45	-0,06	-0,01
INVSERV	-0,43	-0,40	0,75	-0,74	-0,79	1,00	-0,30	0,26	-0,15	0,11	0,44	-0,21	0,39	0,07
PATENT	-0,52	0,84	0,07	-0,05	0,63	-0,30	1,00	0,69	-0,65	0,48	0,26	0,68	0,29	0,59
GDPUL	-0,80	0,54	0,58	-0,54	-0,04	0,26	0,69	1,00	-0,79	0,32	0,37	0,49	0,45	0,77
PUBEXP	0,69	-0,65	-0,26	0,25	0,04	-0,15	-0,65	-0,79	1,00	-0,25	-0,13	-0,33	-0,22	-0,85
STUDENT	-0,21	0,32	0,27	-0,11	0,18	0,11	0,48	0,32	-0,25	1,00	0,37	0,21	-0,10	0,16
R&DEXPPPRI	-0,52	0,06	0,54	-0,52	-0,06	0,44	0,26	0,37	-0,13	0,37	1,00	0,55	0,65	0,05
R&DEXPFIRM	-0,53	0,59	0,16	-0,20	0,45	-0,21	0,68	0,49	-0,33	0,21	0,55	1,00	0,50	0,30
INT	-0,52	0,09	0,48	-0,53	-0,06	0,39	0,29	0,45	-0,22	-0,10	0,65	0,50	1,00	0,30
EXEMP	-0,64	0,58	0,36	-0,27	-0,01	0,07	0,59	0,77	-0,85	0,16	0,05	0,30	0,30	1,00

Table 4 - KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0,609
Bartlett's Test of Sphericity (Approx. Chi-Square)	81.140
df	15
Sign.	0,000

Table 5 - Results of Principal Component Analysis

Component	eigenvalue	% of variance explained	cumulative %
1	2,67	44,45	44,45
2	2,09	34,78	79,23

Extraction Method: PCA

Table 6 - Rotated Component Matrix

Variables	**Component 1** Industrial structure	**Component 2** R&D-based productivity
	1	2
AVIND	0,88	0,27
INVIND	0,89	-0,17
PATENT	0,83	0,48
GDPUL	0,29	0,77
R&DEXPPPRI	-0,12	0,85
R&DEXPFIRM	0,55	0,66

Rotation Method: Varimax with Kaiser Normalization

Figure 5 - Internationalisation and technology effort

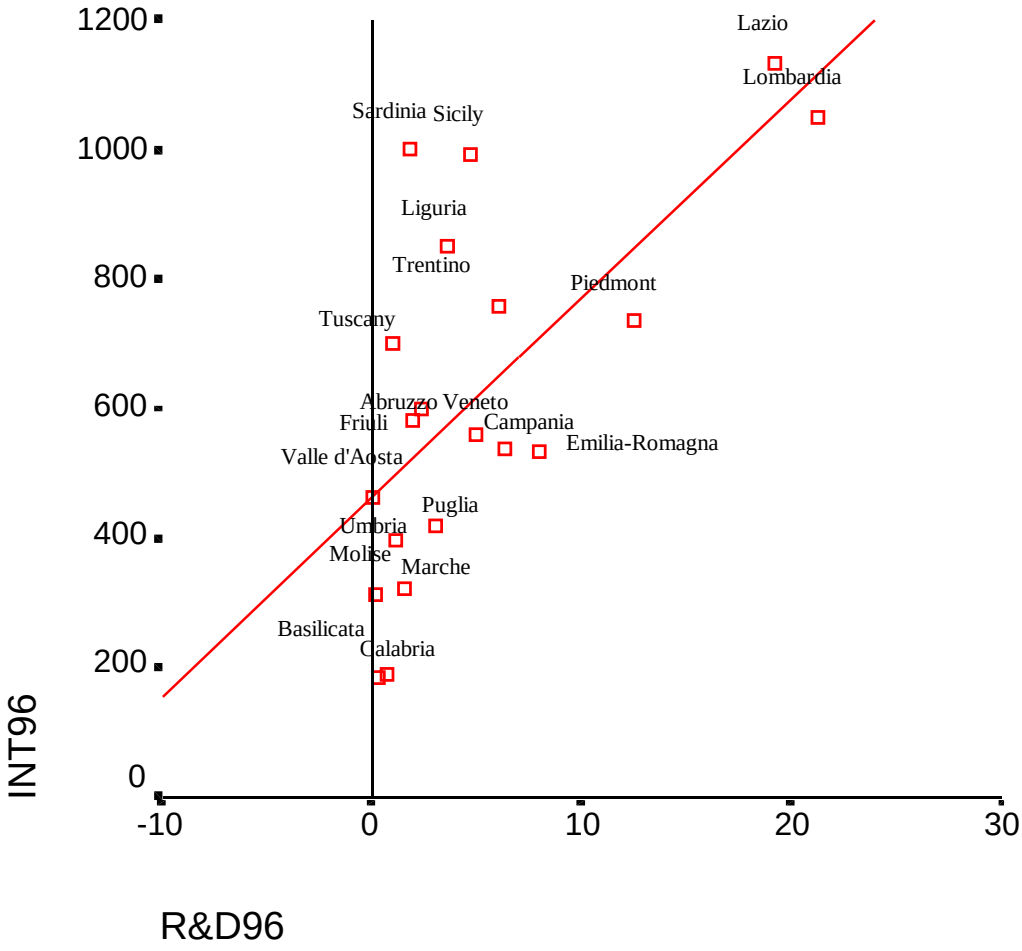


Figure 6 - Scree Plot

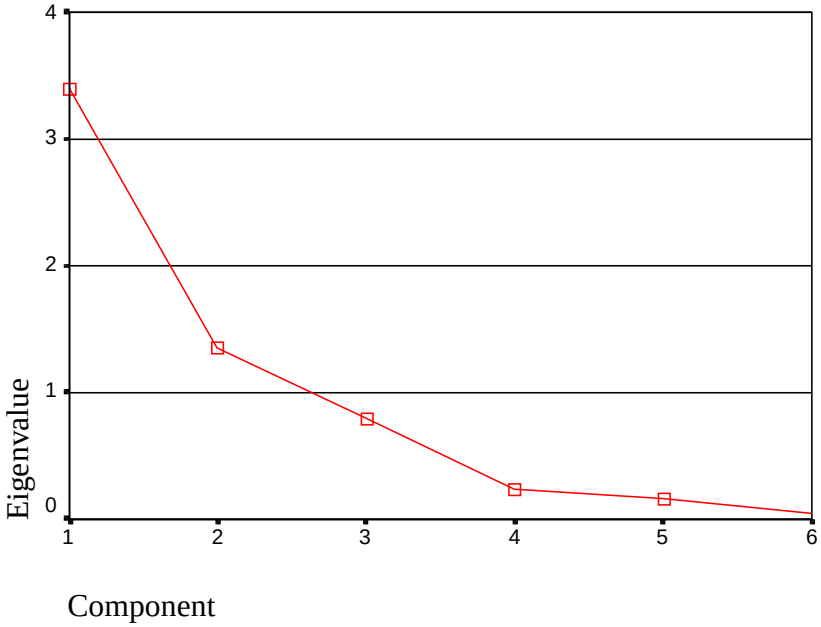
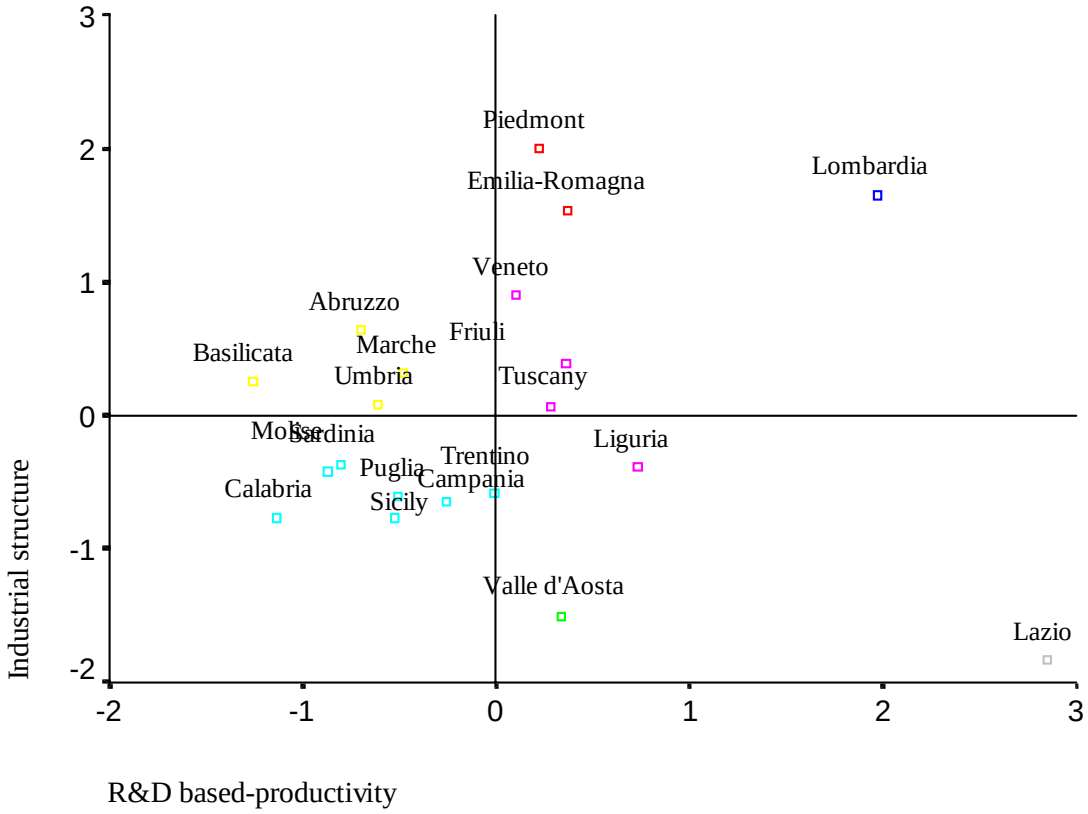


Figure 7 - Regional profiles



Notes

[1] For a critical overview see Fagerberg (1994).
[2] For a comprehensive description of the NUTS classification see Eurostat (1995).
[3] For the aggregation of the Italian regions (NUTS 2 level) into the respective macro-areas (NUTS 1 level) see Table A2.
[4] The *province* represents the NUTS 3 level in the Eurostat disaggregation of the Italian national territory.
[5] Following Becattini (2000), the major sectoral components of a *made in Italy* specialisation can be identified in goods for individual care (clothes, shoes, jewellery, etc.), house furnishing (furniture, ceramics, etc.) and Italian traditional food products (pasta, wine, parmesan, etc.). Taking into consideration sectoral production linkages, under the label of *made in Italy* textiles, chemicals and mechanicals can be also included.
[6] It should be noted that processes of diversification of both production and exports have occurred, particularly towards sectors which are complementary and related to the original specialisation of the region. Indeed, the growing interdependence between SMEs operating in traditional sectors, and machinery and mechanical equipment producers within some industrial districts (such as Carpi in the province of Modena) has played a fundamental role particularly in Emilia Romagna (Guerrieri and Iammarino, 2001). In fact, the linkages between machinery and equipment and lighter manufacturing have developed within geographically concentrated systems of SMEs, thus strongly influenced by the dominant productive culture of local systems and "derived" from competencies and knowledge in traditional productions (Conti and Menghinello, 1998).
[7] The model of basic industrialisation aimed to develop depressed Italian regions by locating here public companies operating in energy sectors in order to boost the local economies. Given the weakness of the industrial structure of the southern regions, the presence of these companies has usually determined the foreign dimension of the Mezzogiorno development.
[8] Onida (1998) acknowledges the wide spread feeling on Italian investments abroad, traditionally perceived as a weakness of the industrial production structure.
[9] It should be underlined that in the Italian context the increase in R&D efforts is usually translated in process rather than product innovation, thus provoking a contained impact on international competitiveness due to the lack of innovative products. This is explicative of the Italian position in the global scenario (Amendola *et al*., 1992).
[10] Guerrieri and Iammarino (2001) discuss the "lights and shadows" characterising the Italian Mezzogiorno highlighting the heterogeneous socio-economic situation.
[11] These variables are reported in *Italics* in Table A3.
[12] The KMO test reveals a good sampling adequacy. The Bartlett's test of sphericity allows us to reject the hypothesis that the population correlation matrix is an identity, thus confirming the absence of zero correlations. Finally the scree plot (see Figure 6) shows a distinctive break between the steep slope of the large components and the gradual trailing off of the rest of the components.
[13] To measure similarity between regions we used the squared Euclidean distance. Regions were then combined together on the basis of the average linkage between groups method.